

## What is Claimed:

- 1                   1.     An ultrafast nonlinear all-optical switch having a switching  
2     speed of less than 1 picosecond for light with a wavelength of about 1.55  
3     micrometers, the switch comprising:
  - 4                   (a)     a substrate; and
  - 5                   (b)     a material disposed on the substrate, the material including a  
6     plurality of carbon nanotubes and a polymer forming a composite.
- 1                   2.     The material according to claim 1 wherein the material is a  
2     third-order nonlinear optical material.
- 1                   3.     The material according to claim 1 wherein the material is  
2     substantially transparent.
- 1                   4.     The material according to claim 1 wherein the polymer is  
2     polyimide.
- 1                   5.     The material according to claim 1 wherein the nanotube  
2     loading is less than about 0.1 wt %.
- 1                   6.     A nonlinear optical material comprising a plurality of  
2     carbon nanotubes and a polymer forming a composite.
- 1                   7.     The material according to claim 6 wherein the material is a  
2     third-order nonlinear optical material.
- 1                   8.     The material according to claim 6 wherein the material is  
2     substantially transparent.
- 1                   9.     The material according to claim 6 wherein the polymer is  
2     polyimide.

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1                   10.    A nonlinear optical article comprising:

2                   (a)    a substrate; and

3                   (b)    the material of claim 6 disposed on the substrate.

1                   11.    The nonlinear optical article according to claim 10 wherein  
2   the article is an ultrafast all-optical switch.

1                   12.    The ultrafast all-optical switch according to claim 11  
2   wherein the switch has a switching speed of less than 1 picosecond for light with  
3   a wavelength of about 1.55 micrometers.

1                   13.    A process for preparing a nonlinear optical switch  
2   comprising:

3                   (a)    preparing a plurality of carbon nanotubes;

4                   (b)    suspending the nanotubes in a solvent;

5                   (c)    sonicating the nanotube-and-solvent suspension, yielding a  
6   suspension with substantially uniformly distributed nanotubes;

7                   (d)    separately dissolving a polymer resin in the solvent, yielding  
8   a polymer solution;

9                   (e)    mixing the nanotube-and-solvent suspension and the polymer  
10   solution, yielding a uniform distribution of nanotubes in polymer solution;

11                  (f)    baking the nanotube-polymer solution to remove most of the  
12   solvent;

13                  (g)    curing the polymer resin;

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14 (h) baking the nanotube-polymer composite to remove any  
15 retained solvent and to form a nonlinear optical nanotube-polymer composite  
16 material; and

17 (i) depositing the material on a substrate.

1 14. The process according to claim 13 wherein the step of  
2 depositing the material on the substrate is accomplished using lithography  
3 techniques.

1 15. The process according to claim 13 wherein the carbon  
2 nanotubes are purified before they are suspended in the solvent.

1 16. The process according to claim 13 wherein the concentration  
2 of the carbon nanotubes is tuned to achieve predetermined properties in the  
3 material.

1 17. The process according to claim 13 wherein the polymer is  
2 polyimide.

1 18. The process according to claim 13 wherein the step of  
2 preparing the nanotubes includes applying the HiPCO method.

1 19. The process according to claim 13 wherein the solvent is  $\gamma$ -  
2 butyrolacetone.

1 20. An ultrafast all-optical nonlinear switch comprising:

2 (a) a substrate; and

3 (b) a material disposed on the substrate, the material including a  
4 plurality of carbon nanotubes incorporated into a silica.

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